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Causes of Climate Change: Review Article

By Selemon Thomas Fakana
Gambella University

Abstract- Climate change refers to a significant change in the measures of climate, such as in temperature, rainfall, snow, or wind patterns lasting for decades or longer. The Earth's climate has changed many times during the planet's history. It is a real and urgent challenge that is already affecting people and the environment worldwide. This review article focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. It helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies. Hence, this article is produced through referring various secondary data sources and desktop data analysis. Accordingly, many factor both natural and anthropogenic activities are drivers of climate change. But, various studies indicated that most of the causes of climate change in the current era is the result of human activities.

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Causes of Climate Change: Review Article

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Abstract- Climate change refers to a significant change in the measures of climate, such as in temperature, rainfall, snow, or wind patterns lasting for decades or longer. The Earth's climate has changed many times during the planet's history. It is a real and urgent challenge that is already affecting people and the environment worldwide. This review article focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. It helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies. Hence, this article is produced through referring various secondary data sources and desktop data analysis. Accordingly, many factor both natural and anthropogenic activities are drivers of climate change. But, various studies indicated that most of the causes of climate change in the current era is the result of human activities.

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I. Introduction

Climate change is a term that refers to major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer (IPCC, 2007a). The United Nations Framework Convention on Climate Change (UNFCCC) uses the term "climate change" to refer exclusively to change brought about by human activities. In particular scientists refer to past climate change and address the complex issue of separating natural and human causes in currently observed changes (Houghton, 1990). Climate change is a real and urgent challenge that is already affecting people and the environment worldwide (Braman *et al*., 2010). Significant changes are occurring on Earth, including increasing air and ocean temperatures, widespread melting of snow and ice, and rising sea levels (EPA, 2010; NRC, 2011). Climate change is a key concern in our time and need to be tackled. It has brought an escalating burden to already existing environmental concerns including deforestation, serious soil erosion and loss of top soil and land degradation which in turn have adversely impacted agricultural productivity (EPA, 2010; MoA, 2011).

Any factor which alters the radiation received from the Sun or lost to space, or which alters the redistribution of energy within the atmosphere, and between the atmosphere, land and ocean, can cause climate change (Houghton, 1990; EPA, 2010). To distinguish anthropogenic climate changes from natural variations, it is necessary to identify the anthropogenic "signal" against the background "noise" of natural climate variability (Houghton, 1996). Most of the climate change in the current era is the result of anthropogenic activities. Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever (IPCC, 2014). This has led to greenhouse gases (CO2, CH4, N2O, etc.), concentrations that trap heat and cause the Earth to warm as well as reduce the efficiency with which the Earth cools to space (IPCC, 2020).Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies (IPCC, 2014). On the other hand, any human-induced changes in climate will be superimposed on a background of natural climatic variations which occur on a whole range of space and time scales (IPCC, 2014a). Natural climate variability can occur as a result of changes in the forcing of the climate system, for example due to aerosol derived from volcanic eruptions. The changes in temperature, precipitation and soil moisture were not uniform over the globe(Houghton,1990; USGCRP, 2009). However, our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability, and because there are uncertainties in key factors (Houghton, 1996; Braman, L. *et al.*, 2010). These include the magnitude and patterns of long term natural variability and the time-evolving pattern of forcing by, and response to, changes in concentrations of greenhouse gases and aerosols, and land surface changes (Houghton, 1996; NRC, 2011).

a) Significance of the Review

Climate change is expected to exacerbate the occurrence and intensity in future which results in negative impacts on social, economic and environmental aspects. Hence, this review is focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. Furthermore, it helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies.

Author: College of Agriculture and Natural Resources, Gambella University, P. o. Box 126, Gambella, Ethiopia.
e-mail: selethom36@gmail.com

II. Methodology

This article is produced through referring various secondary data sources (published and unpublished articles) and observation and desktop data analysis (deep explanation and discussion).

III. Results and Discussions

EPA (2014) states that many factors, both natural and human, can cause changes in Earth's energy balance and climate change, including: variations in the sun's energy reaching Earth; changes in the reflectivity of Earth's atmosphere and surface; changes in the greenhouse effect, which affects the amount of heat retained by Earth's atmosphere.

a) *Anthropogenic Causes*

Human activities have changed and continue to change the Earth's surface and atmospheric composition (IPCC, 2007a). Human-induced activities which cause climate change include burning fossil fuels, cutting down forests, and developing land for farms, cities, and roads. These activities all release greenhouse gases into the atmosphere (EPA, 2010).

i. *Deforestation*

Forests play a critical role in the Earth's climate system, in a number of different ways. Most importantly for global climate change, they capture carbon dioxide from the atmosphere and convert it, through photosynthesis, into living biomass (FAO, 2010). Forests act as natural filters for carbon dioxide absorption in the atmosphere. They store more carbon than they release and are termed as CO2 sinks in their natural state (Negar and Jean 2014). Forest cover regulates the air and surface temperature by absorbing carbon dioxide, with a decrease in the forest cover there would a significant increase in the temperature (Yuksel G., 2014). Where increases in forest cover in tropical regions, cooling results from enhanced evapotranspiration. Increased evapotranspiration can result in cooler days during the growing season (high confidence) and can reduce the amplitude of heat related events (MoA, 2011; FAO, 2011a). When forests are burned or cleared for uses such as cropland, pasture, infrastructure or urbanization, the net flow of carbon from the atmosphere into the forest ends, both in the present and for the entire projected future lifetime of the trees (FAO, 2010). Deforestation also causes the release of the stock of carbon that has accumulated, both in the trees themselves and in the forest soil (David E., 2018). Deforestation at the present rate has resulted in an unprecedented increase of CO2 in the atmosphere for the past years (Adnan et al., 2011). Changes in forest cover directly affect Earth's surface temperature through exchanges of water and energy (IPCC, 2020). Removal of forest cover alters global and regional climate patterns and results in catastrophic rainfall spells followed by prolonged dry periods (Strasser *et al*., 2014).

ii. *Changes in Land-Use*

Land-use change, land-use intensification and climate change have contributed to desertification and land degradation (IPCC, 2020). Changes in the way people use land-for example for forests, farms, cities, etc.-can led to both warming and cooling effects locally by changing the reflectivity of Earth's surfaces (affecting how much sunlight is sent back into space) and by changing how wet a region is(Adnan et al., 2011; David, 2018). Unsustainable land management and land use has led to negative economic impacts which are ex acerbated by the Climate change (IPCC, 2020). Land-use change – converting forests and peatlands to areas of agricultural production also releases carbon stored in the biomass and soil, which contributes a further 10 to 15 percent of total emissions as CO2 (FAO, 2011a).

iii. *Emissions of Greenhouse Gases*

Since the pre-industrial period, the land surface air temperature has raised nearly twice as much as the global average temperature due to emission of greenhouse gases (IPCC, 2007a; IPCC, 2020). Global surface temperatures have risen by about 0.6°C since 1900. It is likely that this warming is larger than for any century since 200AD, and that the 1990s were the warmest decade in the last millennium. The warming differs in different parts of the world, but over the last 25 years, almost everywhere has warmed (Yuksel, 2014; IPCC, 2018). Continuous emission of greenhouse-gases from industrialized nations is resulting in hydro-meteorological events, sea-level rise, and seasonal unpredictability (Adnan et al., 2011; Yuksel, 2014). Globally, economic and population growth continued to be most important drivers of increases in CO_2 emissions from fossil fuel combustion. Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total Greenhouse gases emissions increase from 1970 to 2010 (EPA, 2010; IPCC, 2014).

iv. *Burning Fossil Fuels*

The global agricultural food sector uses more than 30 percent of global end-use energy demand, which is mostly met by fossil fuel sources, and emits around 22% of total anthropogenic greenhouse gases (FAO, 2011a). According to NRC (2011) the Earth is getting warmer because humans are adding heat-trapping greenhouse gases like CO2, N2O, CH4, and water vapor to the atmosphere, mainly by burning fossil fuels. As fossil fuel usage increases, the amount of these gases in the atmosphere rises. Combustion of fossil fuels (burning of coal, oil and natural gas), cement production, etc., increases the level of CO_2 which reduces the CO_2 taken up by trees. Increase in CO_2concentration is the single largest contributor to global warming (IPCC, 2018).

v. *Urbanization*

Urbanization is believed to be a driving force of an economy which facilitates the transfer of surplus labor from the rural agricultural sector to the urban industrial sector and contributes to economic development (Muntasir M. and Syed Y.S., 2018). However, unplanned urbanization can result in negative impacts that adversely affect the economy, deforestation, environmental degradation as well as contribute to global warming and climate change (Zhang, N, Yu, K. and Chen, Z., 2017). Urban expansion can enhance warming in cities and their surroundings (heat island effect), especially during heat related events, including heat waves. Increased urbanization can also intensify extreme rainfall events over the city or downwind of urban areas. This can result in additional risks to the flood system (IPCC, 2020).

vi. *Emissions of Pollutants*

Some industrial and agricultural processes emit pollutants (other than Greenhouse Gases)that produce aerosols (small droplets or particles suspended in the atmosphere) (IPCC, 2020). Some aerosols also affect the formation of clouds, which can have a warming or cooling effect depending on their type and location. Black carbon particles or soot produced when fossil fuels or vegetation are burned, generally have a warming effect because they absorb incoming solar radiation (USGCRP, 2009).Chlorofluorocarbons(CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6), together called F-gases, are often used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants (IPCC, 2013). Unlike water vapor and ozone, these F-gases have a long atmospheric lifetime, and some of these emissions will affect the climate for many decades or centuries (USGCRP, 2014). Black Carbon is a solid particsle or aerosol, not a gas, but it also contributes to warming of the atmosphere. Unlike GHGs, Black Carbon can directly absorb incoming and reflected sunlight in addition to absorbing infrared radiation (IPCC, 2013; Sims, Gorsevski and Anenberg, 2017).

vii. *Agricultural Expansion*

Agricultural activities such as the use of nitrogen-based fertilizers increase the concentrations of Nitrous oxide (N_2O) in the air which causes climate change (MoA, 2011). In similar way human activities such as raising livestock, growing paddy rice, filling landfills, and using natural gas, etc. rise mostly Methane CH_4which is significant contributor to the climate change. It is released by decomposition in swamps, from ruminants, especially cows, and leakage from fossil fuel extraction (Braman et al., 2010).Due to human activities, CH_4 concentrations increased in the 20th century and are now more than twice than pre-industrial level (EPA, 2010). In addition Halocarbons, including chlorofluorocarbons (CFCs), are chemicals used as refrigerants and fire retardants are potential contributors to climate change which can damage the ozone layer. Greater cropland expansion results in larger declines in biodiversity (MoA, 2011; IPCC, 2020).

b) Natural Causes

Although anthropogenic activities are the root drivers of the climate change, there are some of major natural factors influencing climate system (EPA, 2010; IPCC, 2013).

i. *Sun's Intensity*

Climate is influenced by natural changes that affect how much solar energy reaches the Earth's surface (EPA, 2010; IPCC, 2018). Changes occurring in the sun itself can affect the intensity of the sunlight that reaches Earth's surface. The amount of heat energy received at any location on the globe is a direct effect of Sun angle on climate, as the angle at which sunlight strikes the Earth varies by location, time of day, and season due to the Earth's orbit around the Sun and the Earth's rotation around its tilted axis (Khavrus, V. and Shelevytsky, I., 2010). It has been suggested that changes in solar output might affect our climate—both directly, by changing the rate of solar heating of the Earth and atmosphere, and indirectly, by changing cloud forming processes. The intensity of the sunlight can cause either warming (during periods of stronger solar intensity) or cooling (during periods of weaker solar intensity) (USGCRP, 2014; IPCC, 2018).

ii. *Changes in the Earth's Orbit*

According to Rutgers University (2018) Earth's climate is affected by a number of factors dealing with the Earth as a whole, in relation to its position in the space relative to the sun. These factors include the angle of Earth's axial tilt (also known as Earth's obliquity), the eccentricity of Earth's orbit (how circular/elliptical Earth's orbit is), and Earth's position in time in the precession of the solstices and equinoxes (with different Earth-Sun distances during any given season) which contributes to the climate change (William F.R, 2007).

iii. *Changes in Ocean Current Circulation*

Since the 1950s, geologists and oceanographers have been gathering convincing evidence that alteration in ocean current circulation is a key determinant of climate change(Cunningham, 2005; Tierney *et al*., 2013). An ocean current is a continuous, directed movement of sea water generated by a number of forces acting upon the water, including wind, breaking waves, and temperature and salinity differences (England et al., 2014).Ocean current circulation plays a central role in regulating global climate and maintains primary productivity and marine ecosystems (Duteil *et al*., 2014). Ice-core records from Greenland suggest that abrupt shifts in circulation

strength triggered dramatic temperature fluctuations during the last glacial period(Jayne, S. R. and Marotzke, J., 2001; Fischer E. M. and Knutti R, 2015). According to Bryden, H. L. and Imawaki, S. (2001) the Atlantic Meridional overturning circulation carries warm upper waters into far-northern latitudes and returns cold deep waters southward across the Equator1. Its heat transport makes a substantial contribution to the moderate climate of maritime and continental Europe, and any slowdown in the overturning circulation would have profound implications for climate change.

iv. *Volcanic Eruptions*

Volcanic eruption releases molten rock, or lava, from deep within the Earth, greenhouse gases etc. which causes impact the atmosphere (Robock, 2000). The gases, ashes and dust particles thrown into the atmosphere during volcanic eruptions have influences on climate. Most of the particles spewed from volcanoes cool the planet by shading incoming solar radiation (Hyde and Crowley, 2000). Volcanoes vent huge amounts of water vapor and carbon dioxide when they erupt (IPCC, 2012). Considering how small volcanoes are compared to the size of Earth, this activity doesn't have a very large impact on the climate, though that wasn't always the case (William F. Ruddiman, 2007).According to Rutgers University (2018), if we go back four billion years, when Earth was still young, hot, and devoid of life, there was significantly more tectonic activity (the movement of Earth's plates), resulting in constant earthquakes and volcanic actions.

v. *Melting of Glaciers*

Anthropogenic influences have affected the global water cycle since 1960 and contributed to the retreat of glaciers since the 1960s and to the increased surface melting of the Greenland ice sheet since 1993 (Peterson *et al*., 2013). It contributed to Arctic Sea-ice loss since 1979 and has made a substantial contribution to increases in global upper ocean heat content (0–700 m). Global mean sea level rise has observed since the 1970s (You and Ringler, 2010; IPCC, 2014).Over the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass. Glaciers have continued to shrink almost worldwide(You and Ringler, 2010). The atmosphere and ocean have warmed; the amounts of snow and ice have diminished (IPCC, 2012).Glaciers are expected to continue to decrease in size while the rate of melting is expected to continue to increase, which will contribute to Sea level rise (Savage *et al*., 2015).It is retreating almost everywhere around the world including the Alps, Himalayas, Andes, Rockies, Alaska and Africa(NRC, 2011). According to Peterson *et al*., (2013) Antarctica and Greenland has been losing about 134 and 287Gigatonnes of ice per year since 2002 respectively.

vi. *Sea-level rise*

Average Sea level rise is expected to rise as a result of thermal expansion of the oceans and melting of glaciers and ice-sheets (Peterson *et al*.,2013). The major causes of sea-level rise are: thermal expansion and the loss of land-based ice. Thermal expansion is caused by the warming of the oceans (since water expands as it warms); i.e. the warmer oceans occupy more space (You and Ringler, 2010; Hansen, 2016).

The loss of land-based ice (such as glaciers and ice sheets) due to increased melting Sea-levels have risen about 17 cm (global average) since 1900 because of thermal expansion of ocean water and melting of glacier ice (Peterson *et al*., 2013; Hansen, 2016). Sea level rise has increased from 1mm/year 100 years ago to 3 mm/year today. The primary contributions to changes in the volume of water in the ocean are the expansion of the ocean water as it warms and the transfer to the ocean of water currently stored on land, particularly from glaciers and ice sheets (Fischer and Knutti, 2015; Savage *et al*., 2015).

IV. Conclusion and the Way Forward

Anthropogenic activities and natural processes that alter the Earth's energy budget are major drivers of climate change. Human activities have changed and continue to change the Earth's surface and atmospheric composition. Some of these changes have a direct or indirect impact on the energy balance of the Earth which causes climate change. Human activities resulted in changes in rainfall patterns across the globe with increasing floods, drought frequency and severity, heat stress, wind, sea-level rise and wave action (IPCC, 2020).Climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems. Warmer temperatures will lead to a more vigorous hydrological cycle; this translates into prospects for more severe droughts and/or floods in some places.

Many factors currently limit our ability to project and detect current and future climate change. Sustainable land management, including sustainable forest management, can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation. Sustainable forest management can maintain or enhance forest carbon stocks, and can maintain forest carbon sinks. In particular, to reduce uncertainties of climate change further work is needed like (i) reducing anthropogenic activities those cause climate change (ii) estimation of future emissions and biogeochemical cycling (including sources and sinks) of greenhouse gases, aerosols and aerosol precursors and projections of future concentrations and radiative properties; (iii) representation of climate processes in

models, especially feedbacks associated with clouds, oceans, sea ice and vegetation, in order to improve projections of rates and regional patterns of climate change; (iv) systematic collection of long-term instrumental and proxy observations of climate system variables (e.g., solar output, atmospheric energy balance components, hydrological cycles, ocean characteristics and ecosystem changes) for the purposes of model testing, assessment of temporal and regional variability and for detection and attribution studies.

References Références Referencias

1. Adnan A.T., Pierre C., Yves A., Luc N. and Bashir A., (2011). Modeling snowmelt-runoff under climate scenarios in the Hunza River basin, Karakoram Range, Northern Pakistan, Journal of Hydrology, 409, 1–2, Pp. 104–117
2. Braman, L. et al. (2010). Climate change adaptation: integrating climate science into humanitarian work. International Review of the Red Cross. 92:879 Pp. 693-712
3. Bryden, H. L. and Imawaki, S. (2001). In Ocean Circulation and Climate (EdsSiedler, G., Church, J. and Gould, J.) Ch. 6.2 455–474 (Academic, London, 2001)
4. Cunningham, S. A. (2005). RRS Discovery Cruise 279 (04 Apr–10 May 2004): A Transatlantic Hydrography Section at 24.5° N Cruise Report 54, 1–199 (Southampton Oceanography Centre, Southampton, 2005) http://eprints.soton.ac.uk/17527/
5. David E. (2018). Forests and Water; Background analytical study prepared for the thirteenth session of the United Nations Forum on Forests, April 2018.
6. Duteil O., Böning C. W. And Oschlies A. (2014).Variability in Subtropical-Tropical Cells Drives Oxygen Levels in the Tropical Pacific Ocean. Geophysical Research Letters, 41 (24). pp. 8926-8934.
7. England M. H., Mcgregor S., Spence P., Meehl G. A., Timmermann A., Cai W., Sen Gupta A., Mcphaden M. J., Purich A. And Santoso A. (2014). Recent Intensification of Wind-Driven Circulation in the Pacific and the Ongoing Warming Hiatus. Nature Climate Change, 4, 222-227.
8. Fischer E. M. and Knutti R. (2015). Anthropogenic contribution to global occurrence of heavy-precipitation and hightemperature extremes. Nature Climate Change, vol. 5, no. 6, pp. 560–564.
9. Hansen J. (2016). Ice Melt, Sea Level Rise and Super storms: Evidence from Paleo climate Data, Climate Modeling, and Modern Observations that 2°C Global Warming Could Be Dangerous. Atmospheric Chemistry and Physics, 16(6), pp. 3761–3812.
10. Houghton J.T, Jenkins G.J and Ephraumis J.J., 1990). Climate Change. The IPCC Scientific Assessment. Report Prepared for IPCC by Working Group I. Press Syndicate of the University of Cambridge.
11. Houghton J.T, Meira Filho, L.G, Callander B.A, Harris N, Kattenberg A and Maskell K., 1996). The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Press Syndicate of the University of Cambridge.
12. Hyde W.T, Crowley T.J (2000). Probability of future climatically significant volcanic eruptions. J Clim 2000, 13:1445–1450.
13. Intergovernmental Panel on Climate Change (IPCC) (2007a). Climate Change 2007 – The Physical Science Basis. Cambridge University Press, Cambridge.
14. Intergovernmental Panel on Climate Change (IPCC) (2012), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, C. B. Field, V. Barros, T. F. Stocker et al., Eds., Cambridge University Press, Cambridge, UK.
15. Intergovernmental Panel on Climate Change (IPCC) (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
16. Intergovernmental Panel on Climate Change (IPCC) (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (Eds.)]. IPCC, Geneva, Switzerland.
17. Intergovernmental Panel on Climate Change (IPCC) (2014a). Summary for policymakers, Climate Change 2014: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
18. Intergovernmental Panel on Climate Change (IPCC) (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W.

Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

19. Intergovernmental Panel on Climate Change (IPCC) (2020). Climate Change and Land. An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems; Summary for Policymakers.
20. Jayne, S. R. and Marotzke, J. (2001). The dynamics of ocean heat transport variability. Rev. Geophys. 39, 385–411.
21. Khavrus, V. and Shelevytsky, I. (2010). Introduction to solar motion geometry on the basis of a simple model. Physics Education. 45 (6): 641. Bibcode: 2010PhyEd.45.641K. doi:10.1088/0031-9120/45/6/010.
22. Ministry of Agriculture (2011). Agriculture Sector Programme of Plan on Adaptation to Climate Change. Addis Ababa, Ethiopia.
23. Muntasir M. and Syed Y.S. (2018). Effects of Urbanization on Climate Change: Evidence from Bangladesh. Journal of Natural Sciences Research. Vol.8, Special Issue for ICNST. Pp. Pp. 1-8.
24. National Research Council (NRC) (2010). *Advancing the Science of Climate Changes.*The National Academies Press, Washington, DC, USA.
25. National Research Council (NRC) (2011). Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. The National Academies Press, Washington, DC, USA.
26. Negar H. and Jean P. B., 2014, Geomorphological analysis of the drainage system on the growing Makranaccretionary wedge, Geomorphology, 209, Pp. 111–132.
27. Peterson, Hoerling, Stott, andHerring (2013). Explaining extreme events of 2012 from a climate perspective," Bulletin of the American Meteorological Society, vol. 94, no. 9, pp. S1–S74.
28. Robock A. (2000). Volcanic eruptions and climate. Rev Geophys 2000, 38:191–219.
29. Rutgers University (2018). Earth's orbital changes have influenced climate, life forms for at least 215 million years: Gravity of Jupiter and Venus elongates Earth's orbit every 405,000 years, Rutgers-led study confirms. Science Daily. www.sciencedaily.com/releases/2018/05/180507153109.htm
30. Savage M., Mujica A., Chiappe F and Ross I. (2015). Climate Finance and Water Security: Bangladesh Case Study, Oxford Policy Management Limited, Oxford, UK.
31. Sims R., Gorsevski V. and Anenberg S. (2017). Black carbon mitigation and the role of the Global Environment Facility: A STAP advisory document. Washington, D.C; GEF. Available http://www.stapgef.org/node/1607.
32. Strasser U., Vilsmaier F., Prettenhaler T., Marke R., Steiger A., Damm F., Hanzer R., Wilcke J. and Stötter J., 2014, Coupled component modeling for inter- and trans-disciplinary climate change impact research: Dimensions of integration and examples of interface design, Environmental Modeling and Software, 60, Pp.180–187.
33. Tierney J. E., Smerdon J. E., Anchukaitis K. J. Anchukaitis, and Seager R. (2013). Multidecadal variability in East African hydroclimate controlled by the Indian Ocean. Nature, vol. 493, no. 7432, pp. 389–392.
34. United Nations Food and Agricultural Organization (FAO) (2010). Global Forest Resources Assessment.
35. United Nations Food and Agricultural Organization (FAO) (2011a). 'Energy-Smart' Food for People and Climate. Issue paper. Rome: FAO. Available at http://www.fao.org/3/i2454e/i2454e00.pdf
36. United States Environmental Protection Agency (EPA) (2010). Climate Change Science Facts. www.epa.gov/climatechange.
37. United States Global Change Research Program (USGCRP) (2009). *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). Cambridge University Press, New York, NY, USA
38. United States Global Change Research Program (USGCRP) (2014). *Climate Change Impacts in the United States: The Third National Climate Assessment.* [Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds.]
39. William F. Ruddiman (2007). Earth's Climate: Past and Future (2nd Edition)
40. You G. J. Y. and Ringler C. (2010). Hydro-Economic Modeling of Climate Change Impacts in Ethiopia (No. 960), International Food Policy Research Institute (IFPRI).
41. Yuksel G. (2014). Sea surface temperature anomalies at the Mediterranean Coast of Turkey (Period: 1968–2010), Procedia–Social and Behavioral Sciences, 31, Pp. 476–486.
42. Zeilinga de Boer J, Sanders DT (2002). Volcanoes in Human History. Princeton University Press, Princeton, NJ; 2002.
43. Zhang, N, Yu, K. and Chen, Z. (2017). 'How does urbanization affect carbon dioxide emissions? A cross country panel data analysis', Energy Policy, Vol. 107, Pp. 678-687.